HIGH-PERFORMANCE FM-IF AMPLIFIERS USING μA703

by Ted Hanna

ABSTRACT

Four-stage, integrated FM-IF amplifiers are discussed and compared in relation to component count and performance characteristics. Design notes for four-stage, integrated FM-IF amplifiers and a three-stage, integrated FM-IF amplifier are given. FM-IF transformer characteristics and an FM-AM integrated IF amplifier are discussed in the Appendices.

DISCUSSION

This note describes integrated FM-IF amplifiers or strips (using μA703's) whose performance compares favorably with the higher quality discrete component IF strips (e.g., using SE1001's) currently available. A capture ratio of less than 1 db is obtained with an integrated four-stage amplifier. The performance of this strip, as compared to high-quality discrete ones, is tabulated in Table I. All measurements were made with a signal generator connected into the strip rather than into a tuner, since the input impedance of the μA703 is typically 0.35 + j 0.6 mmho, compared to 0.8 + j 1.4 mmho for an SE1001. Also, audio output was taken directly off one side of a balanced 10-KΩ load through a 75-μsec de-emphasis filter. Except where otherwise specified, measurements are as per Institute of High Fidelity Standards Manufacturers, IHFM-T-100, Addendum I.

TABLE I.
PERFORMANCE OF FOUR-STAGE FM-IF USING (1) IC's and (2) DISCRETE DEVICES.

MEASUREMENT	PERFORMANCE	
	Integrated Circuits	Discrete Devices
Sensitivity	11 μV	16 μV
Capture Ratio at 100μV	0.85 db	2.92 db
Selectivity (-30 db, 100% modulated)		
Alternate channel	-46 db	-45 db
AM Rejection	-44 db	-37 db
Bandwidth (-3 db)	180 KHz	180 KHz
Output Voltage into 10 KΩ	0.30 V rms, balanced	0.35 V rms, balanced
Distortion at 1000 Hz	0.3%	0.3%
Supply requirements	38 mA at 12 VDC	22 mA at 12 VDC

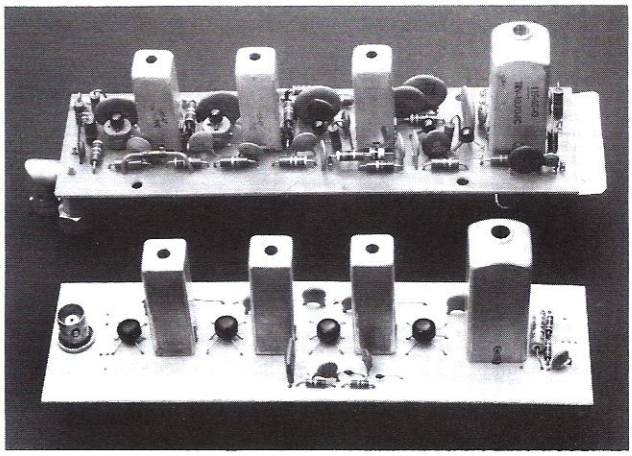

Fig. 1. FM-IF strips showing assembly with discrete components (top view) and clean, simplified construction with integrated circuits (bottom view).

The component count of this strip compared to a high-quality discrete component strip is given in Table II and shown photographically in Fig. 1. Four μA703 integrated

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RF-IF amplifiers are used, resulting in a clean, easily assembled strip.

TABLE II.

FOUR-STAGE FM-IF STRIP COMPONENT COUNT--COMPARISON.

COMPONENT	DEVICE COUNT	
	IC Board	Discrete Board
Semiconductors		
Active	4	5
Diodes	4	4
Transformers	4	4
Resistors	4	30
Capacitors	14*	27
Coils/chokes	4*	1
	34 (27*)	71

*Two capacitors and two chokes could be eliminated by reducing the by-passing of the supply line. Two capacitors and one coil would normally be eliminated by link-coupling the IF input to tuner output transformer.

DESIGN NOTES

Four-stage Integrated FM-IF Amplifier

A coupling factor of kQ = 0.8 was chosen for the IF transformers in a four-stage FM-IF strip (Fig 2) for good phase linearity. The taps on these transformers are adjusted to present approximately 0.455 mmho to the output of the μA703 to ensure its operation in its current-limiting mode. The input of the μA703 sees approximately 5 mmho to make the secondary Q almost independent of normal device input parameter variations. (Winding data are given in Appendix 1.)

The ratio detector coil has a coupling factor of kQ = 1.4 for a wideband flat response. It is similar to TRW coil No. 21791, except that the bifilar primary is not required.

Single-Ended Four-stage FM-IF Amplifier

Periodic requests for single-ended output ratio detector circuits for use with the integrated FM-IF strip resulted in the development of the circuit in Figs. 3 and 4. The transformer used is a TRW 21732-R1. The board layout is as in Fig. 3. Performance of this modified strip is roughly equivalent to that of the original.

Three-stage Integrated FM-IF Amplifier

The characteristics in Table III may be obtained with three μA703 IF stages. The circuitry used is the same as for the four-stage, except for different IF transformers and, of course, one less stage (See Fig. 5.) The measurements were made according to IEEE Standard No. 185 but with the signal fed directly into the IF.

TABLE III.

THREE-STAGE INTEGRATED FM-IF CHARACTERISTICS.

MEASUREMENT	PERFORMANCE
Quieting-Signal Sensitivity	18 μV
Co-Channel Interference (1000 μV)	-3 db
Selectivity (100 μV)	
Adjacent Channel	0.2 db
Alternate Channel	-19 db
AM Suppression (2000 μV)	-38 db
Bandwidth (-3 db)	190 KHz
Output Voltage (10-KΩ load, 30% mod.)	100 mV rms
Power Supply Requirements	15 V, 35 mA

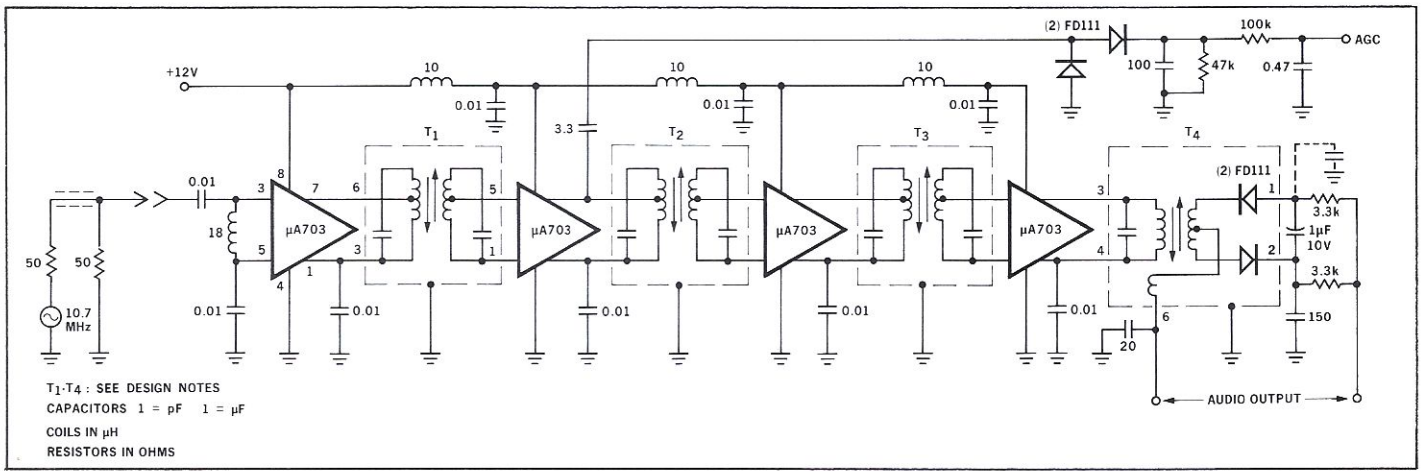

Fig. 2. Four-stage FM-IF amplifier.

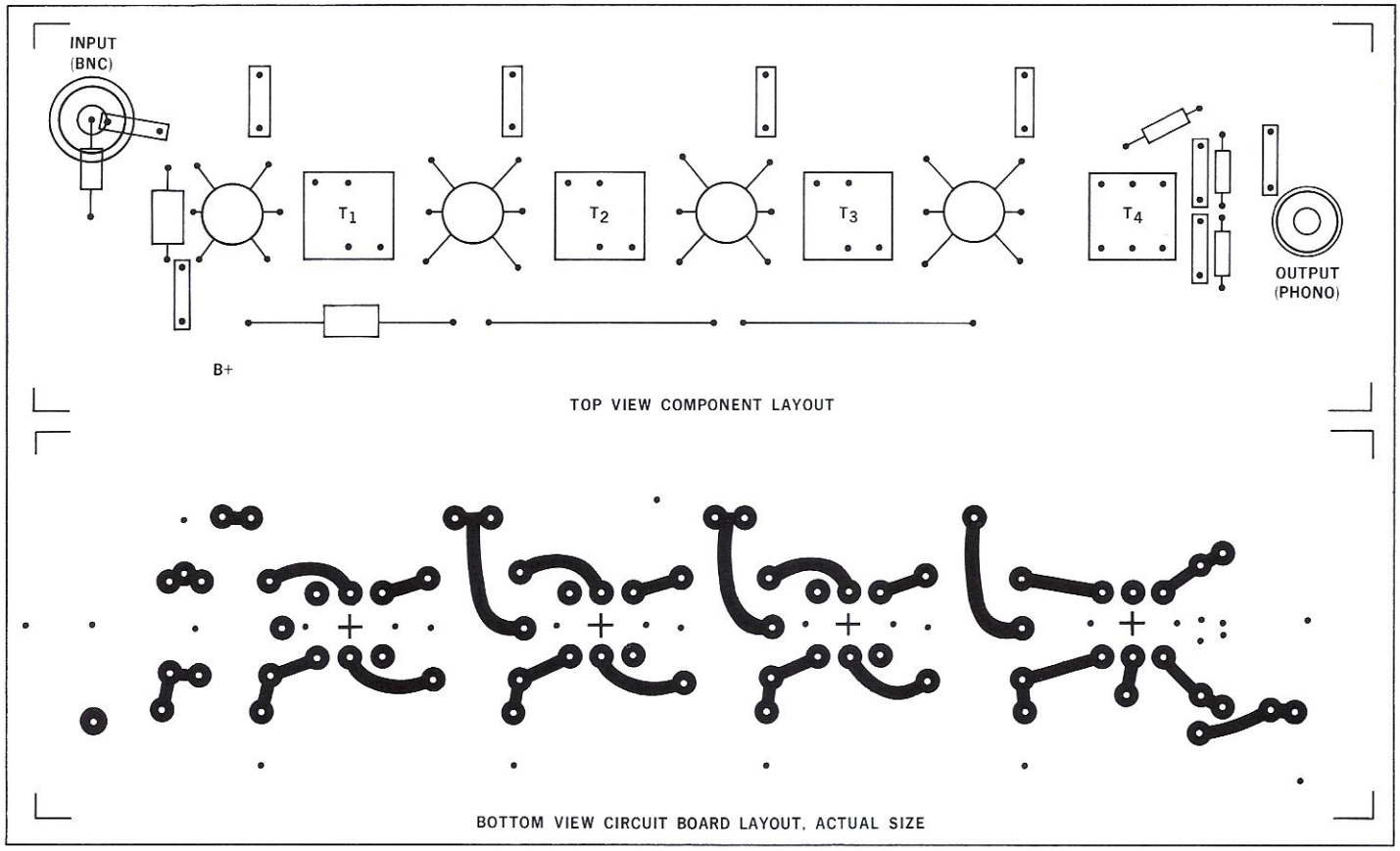

Fig. 3 FM-IF PC board layout using μA703's.

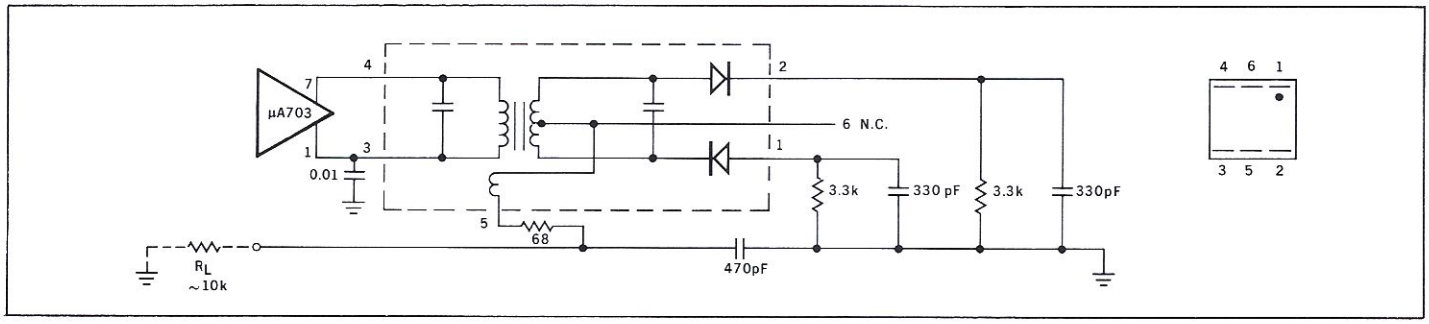

Fig. 4. Modified ratio detector with μA703.

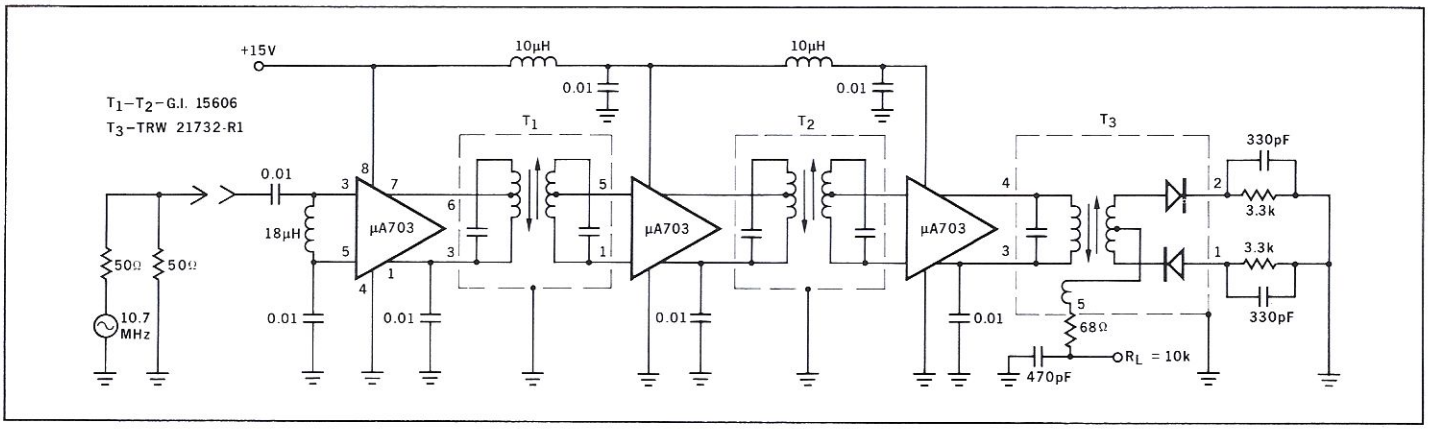

Fig. 5. Three-stage integrated FM-IF amplifier.

APPENDIX I.

FM-IF Transformer Specifications

Specifications for the transformers for both four-stage and three-state integrated FM-IF amplifiers are presented.

Transformer Specifications For Four-Stage μA703.

The transformer for the four-stage FM-IF μA703 has the characteristics given in Table IV. Figure 6 is a bottom view of the transformer.

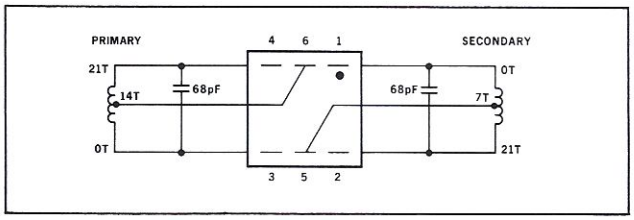

Fig. 6. Four-stage FM-IF transformer, bottom view.

Transformer Specifications For Three-Stage μA703.

The transformer specifications for the three-stage FM-IF μA703 are presented in Table V. The transformer circuit (bottom view) is shown in Fig. 7.

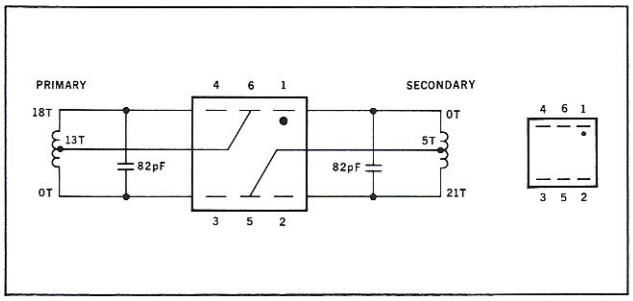

Fig. 7. Transformer for three-stage FM-IF.

TABLE IV.

TRANSFORMER SPECIFICATIONS FOR FOUR-STAGE μA703.

ITEM	SPECIFICATION
Wire	No. 36 SNB
Form	7/32" OD x 1-1/2" L (TRW 7M56BB1)
Cores (2)	TRW E0640
Capacitors (2)	68 pf, silver mica
Primary	21 turns (pins 3 to 4) Tap 14 Turns from cold end (pins 3 to 6), R_P = 19.3 KΩ $R_{P,tap}$ = 3.28 KΩ
Secondary	21 turns (pins 2 to 1) Tap 7 turns from cold end (pins 5 to 1), R_S = 19.3 KΩ $R_{S,tap}$ = 350 Ω
Coupling	With 4.7-KΩ load, terminals 1 to 5, kQ = 0.8. In circuit bandwidth: -1 db at 2Δf = 180 KHz -3 db at 2Δf = 270 KHz -10 db at 2Δf = 490 KHz.

TABLE V.

TRANSFORMER SPECIFICATIONS FOR THREE-STAGE μA703.

ITEM	SPECIFICATION
Wire	No. 36 Sodereze
Form	7/32" OD x 1-1/2" (TRW7M56BB1)
Cores (2)	TRW E0609E
Capacitors (2)	82 pf, silver mica
Primary	18 turns (pins 4 to 3), Q = 55. Tap 13 turns from cold end (6 to 3)
Secondary	21 turns (2 to 1), Q = 62. Tap 5 turns from cold end (5 to 1). With R_L = 3.9 KΩ, pin 5 to pin 1; Q measured across pin 2 to pin 1, Q = 55.
Coupling	With secondary loaded as above and resonated with 82 pf silver mica, primary Q = 30.5. In circuit: 3-db bandwidth = ± 115 KHz.
Part No.	G.I. 15606

APPENDIX II.

FM-AM Integrated IF Amplifier

The high, stable gain of the μA703 can be used to advantage as an FM-AM IF amplifier. The block diagram in Fig. 8 shows a configuration in which the μA703 has been used successfully for FM-AM application.

If additional AGC is required, approximately 20-db AGC action can be obtained from Circuit No. 1 in Fig. 9, and 55 db from Circuit No. 2 in Fig. 10.

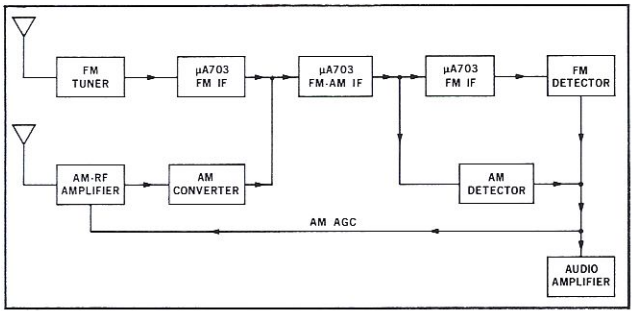

Fig. 8. Use of μA703 in FM/AM Amplifier.

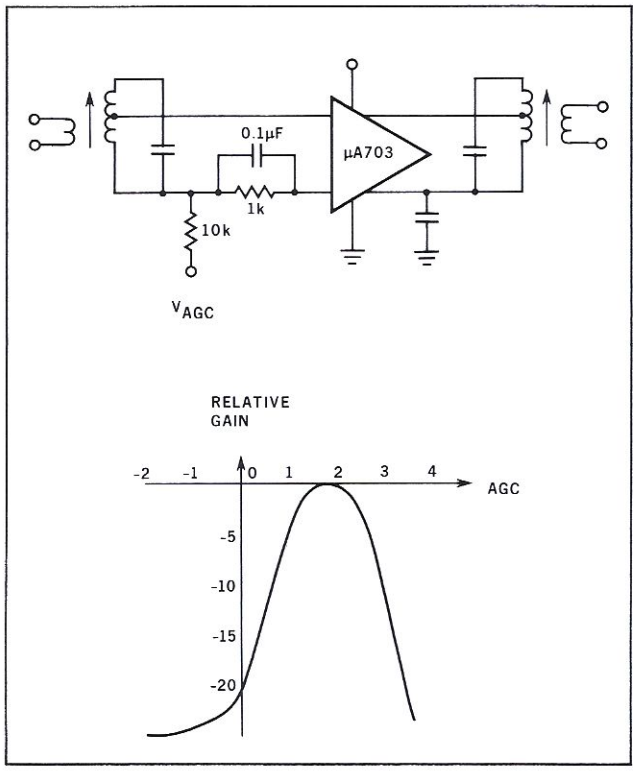

Fig. 9. AGC circuit No. 1.

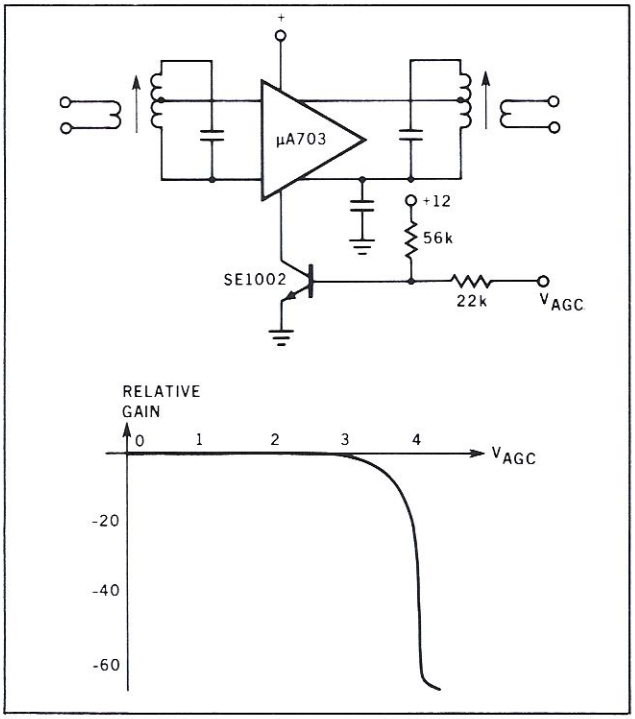

Fig. 10. AGC circuit No. 2.

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